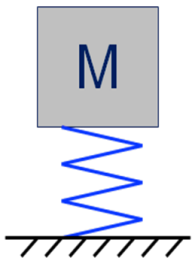
HUTCHINSON®
AEROSPACE & INDUSTRY

Q: Can I improve isolation performance by adding a second stage of isolators to my system?

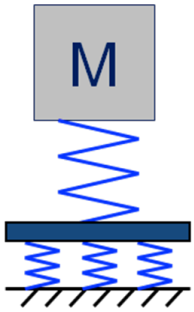
A: A 2-stage isolation system can be a very effective approach to protecting against vibration and noise, depending on the level of complexity of the isolation system.

A simple 2-stage system is only likely to be effective if you are trying to reduce noise, not vibration. If vibration isolation is important, a more complex approach must be considered.

In a normal, single stage mounting system:



… isolation improves above resonance with increasing frequency. For every 2x increase in frequency, the isolation improves by 6 dB. This is known as a 6dB/octave roll off. The real benefit of a 2-stage mounting system:



… is that the isolation improves above resonance at 12dB/octave. Thus at high enough frequencies, the isolation could be as much as twice as good as with the single stage system. See Figure 1 on page 2.

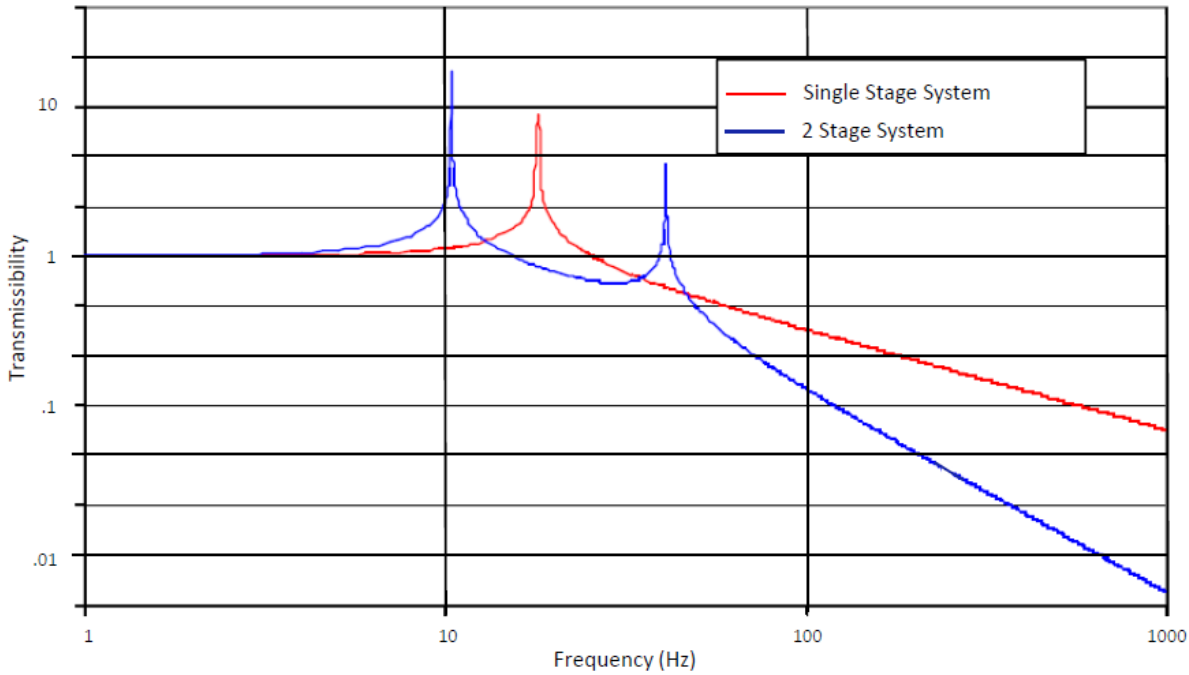
The issue is in the phrase, "above resonance". With the 2-stage system, you now have to look at the interactions between 2 sets of springs and 2 masses. There are no longer 6 resonant frequencies but 12, and more of them are likely to cause trouble.

Consider the example of a genset. The 2 sets of springs are 2 sets of isolators. The 2 masses are the genset mass and the mass of the frame that supports the genset. The upper set of isolators attaches

to the frame and support the weight of the genset. The lower set of isolators support both the weight of the genset and the frame, so these isolators have to have higher load capacity. Typically, then, they are stiffer than the upper set. If the frame is a normal genset frame, it weighs considerably less than the genset. At this point you can see that there's one dynamic system where the mass is the frame and the stiffness is the lower set of isolators (actually it's both sets acting together but don't worry about that now). The frame is relatively light and the isolators are stiff. That means the natural frequency of the frame on the lower set of isolators is going to be quite high. Since the extra 6 dB of isolation doesn't occur until frequencies above resonance, and the resonant frequency of the frame on the lower mounts is high, vibration reduction is diminished. If the resonant frequency of the frame on the lower isolators is near the engine's operating speed, it may make things worse.

In a properly designed 2-stage system, a significant amount of mass needs to be added to the frame. In fact, the frame is usually weighted until it's several times (2x-10x) the weight of the genset. The lower isolators then have to be correspondingly robust. These systems are very effective, but very heavy. This eliminates the simple expedient of putting isolators under the existing frame.

Remember, the precautions above are for vibration, or the engine's firing pulses in this example. If the issue is noise, the solution is simpler. Noise is higher-frequency, so the excitations should be well above even the higher resonant frequencies. The simple approach is somewhat effective against noise, and it's not very expensive. The chances of its actually making the vibration worse are small. For noise, the rule of thumb is that the supporting frame should be 25-30% of the entire system weight.



Frequency vs. Transmissibility Comparison